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# CONNECTION OF START-STOP REGENERATORS AT SUBSCRIBERS' TELEGRAPH STATIONS

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The article examines the problem of applying start-stop regenerative relaying for correction of telegraph signals transmitted in subscribers' telegraph (AT) communications, and presents the circuit of an accessory device which makes possible the use of one and the same relaying in both directions of transmission. The problem is also examined of the place of connecting these relayings in the circuits of the subscribers' telegraph stations.

The system of subscribers' telegraphy, which has been widely developed in Russia, is built on the principle shown in the schematic diagram of Figure 1. In this Figure GU is the main junction station,
OU is the oblast junction station,
RU is the rayon junction station,
Ab is the subscriber's telegraph installation.

As is evident from the drawing, the number of stations that participate in the establishment of a connection can be as many as 6.

To organize temporary communications between subscribers' sets which are located in different inhabited points, the channels of telegraphic relaying (TT) are customarily used. If besides, the line of transmission consists of several sections, then the distortions of telegraph signals, which arise in separate sections, summarizing accordingly, will reduce the reserve of communications stability. In certain cases they can even surpass the correcting capacity of the subscribers' start-stop equipment.

According to established standards, the channel of telegraphic relaying is considered good for operation if the magnitude of distortion does not exceed 10% on one section, 18% on 2 sections, and 24% on 3 sections.

The equipment of the subscribers' telegraph stations, which are in principle similar to the receiving-transmitting parts of simple telegraphic relayings, also introduce distortion. If the subscribers' telegraph stations are employed in the capacity of intermediate stations, then the distortions introduced by each of them amounts to 2 or 3%. But if they are used as terminals, then the distortions reach 5 to 10%. The explanation of the latter is that the subscribers' sets are connected in a semi-duplex circuit, and in the section from the station to the subscriber's set the transmission is accomplished by a single-pole method.

It is moreover necessary to consider the usual distortions introduced by the start-stop equipment itself, which can be increased because of the absence of constant skilled control of the subscribers' installations.

It follows that while the distortions conditioned by the equipment and channels are not summarized arithmetically, the subscribers' communications operating even through one intermediate station may nevertheless have an extremely small reserve of stability, inasmuch as the effective correcting capacity of the start-stop equipment is within the limits of 25 to 30%.

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As is known, the small reserve of communications stability stipulates the necessity of sufficiently accurate regulation of the phase of reception, the optimal position of the phase setter being varied in dependence on the number of the transit stations and channels which participate in one or another connection, the quality of tuning, and so forth. It is difficult to carry out this regulation under the operating conditions of subscribers' sets; the more so, since it demands of the service personnel not only expenditure of time but also adequate skill.

Therefore, to heighten the quality of subscribers' telegraph communications, the telegraph signals which are distorted in the process of their passage through separate sections of the line should be corrected. This can be realized by means of start-stop regenerative relayings which are connected at the transit stations of the subscribers' telegraph. The main junction stations of the subscribers' telegraph system must first of all be equipped with such relayings, or regenerators as it is customary to call them, inasmuch as the greatest number of transit connections passes through them. The need for regenerators will be less at oblast junction stations, since these stations are mainly intermediate only when connections are made between the subscribers of rayon junction stations.

Special research work has to be carried out to determine the total number and type of regenerators necessary for servicing the growing system of subscribers' telegraphy. However, it can be said with certainty that a large number of them will be needed for this purpose.

Considering the relatively high cost of regenerators, it is necessary first to elaborate methods of connecting them in the circuits of the subscribers' telegraph stations such that the most effective use of the indicated equipment will be secured. Soviet specialists have created an extremely simple additional device (DVU) which, considering the alternate character of the work of subscribers' sets, permits using every start-stop regenerator in both directions of transmission. Due to this device the required number of regenerators is halved.

The indicated device automatically reverses the input and output of the regenerator depending on which of the subscribers (the one calling or the one being called) conducts the transmission. Inasmuch as the transmission usually begins with the subscriber who makes the call, the initial operating position of the regenerator is connected in the circuit of this subscriber's transmission. But the reversing of the generator's input and output occurs only at those times when the subscriber called conducts the transmission.

The principle of the circuit of the additional device DVU is shown in Figure 2. This device consists of 3 relays: telegraph relay A and 2 telephone relays V and P. Relay A serves for reception of telegraph signals which enter from the side of the subscriber called and for control of the reception relay of the regenerator. The relay V realizes the connection of the regenerator, and the relay P switches over the regenerator from the circuit of transmission to the circuit of reception. The relay P has 3 windings. Winding I of this relay is the operating one; winding II the magnetizing; winding III retards the release of the armature by 250 to 300 milliseconds.

Let us examine the operation of the DVU circuit.

Connection of the regenerator: as long as the connection with the set of the subscriber called has not been completed, the elements of the DVU circuit are in a state of rest. Besides, the contacts $v_1$ and $v_3$ of

the circuit of transmission (terminals 1 to 4) and the circuit of reception (terminals 2 to 5) are connected straight with the result that a through line is created for passage of dialling impulses through the additional device DVU.

At the automatic station AT of the subscribers' telegraph the connection of the regenerator in the transmission circuit when a transit connection has occurred, occurs automatically by means of relay V. The latter operates from the reply signal (plus) which enters from the side of the subscriber called.

If regenerators are installed at manual service stations of the subscriber's telegraph, then it is not possible to use the action of the reply signal for their connection, since in this case the change of polarity (from minus to plus) occurs when the plug is put in the socket of the line going to the station called. Therefore, the connection of regenerators at stations of manual service must be done by hand by means of the push button KnV installed on the switchboard (in Figure 2 the connection of KnV is shown by dotted lines).

Transmission from the side of the subscriber making the call: The telegraph signals which enter the input 1 of the additional device DVU pass through the circuit: terminal 1, contact $v_1$, the left (in the diagram) contact and armature of relay A, the [illegible] contacts $p_1$ and $v_2$, terminal 4.

At the same time at the input 5 a plus enters from the side of the subscriber called with the result that current passes through the winding of relay A and the winding I of relay P. Under the action of this current relay A holds its armature at the left contact. Relay P does not operate since current passes in the opposite directions in its windings I and II.

To the side of the subscriber making the call a plus is delivered through the contacts $p_2$ and $v_3$ and terminal 2.

Transmission from the side of the subscriber called: The first start (minus) signal entering from the line at terminal 5 passes, branching through the winding of relay A and the winding I of relay P. In consequence of this, the armature of relay A is thrown over to the right contact and transmits the start signal to the input of the regenerator. Since the direction of the current in winding I of relay P is changed, the latter operates.

Contact $p_3$ closes the winding III of relay II thereby preventing release of the armature of this relay during the passage of working signals which enter from the side of the subscriber called. Contact $p_2$ connects the output of the regenerator to terminal 2, i.e., to the channel going to the side of the subscriber making the call. The contact $p_1$ closes the straight circuit from terminal 1 to terminal 4, along which the plus will be delivered from the subscriber making the call to the subscriber called.

When the called subscriber finishes the transmission, the relay P releases its armature, and the regenerator is automatically switched over to the original position.

The duration of the relay P operation amounts to 8 to 10 milliseconds. Therefore, it succeeds in realizing the required switch over before the moment the start signal enters from the output of the regenerator, since

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the latter, as is known, always shifts the phase of the received signals a minimum by half the elementary signal. Secured by this is the undistorted transmission of the first signal received from the subscriber called.

The choice of a place to connect the regenerators in the circuit of the subscribers' telegraph stations also has great importance, in particular for automatic stations at which the regenerators must constantly be connected in appropriate circuits.

At the stations of manual service the question of the place of connecting the regenerators is decided simply enough. The input and output of every regenerator are connected with the corresponding sockets of the switchboard, and when necessary the operator, switching the transit connection, switches in the regenerator. For this purpose, the second plug of the cord pair used for connection with the required station, is put not in the socket of the channel but in the input socket of the regenerator. Its output socket is connected by an additional 3-wire cord to the channel socket. For connection of the regenerator the operator presses push-button'K 7. If a station of manual service is called, then the push button should be pressed immediately after sending the call. But if a station of the automatic system is called, then the push button is pressed at the conclusion of dialling the number.

At stations of the automatic system the indicated problem has to be solved otherwise. In making transit connections at automatic stations circuits are created between the incoming group selectors IV-GI and the outgoing group selectors II-GI. The circuit of the station is designed in such a manner that in the process of making connections any of the free II-GI group selectors that belong to that group of directions among which is found the direction to the station being called, can be occupied by IV-GI group selectors. Consequently, in case of direct connection of the regenerators in the circuits which are formed between the IV-GI group selectors and the II-GI group selectors, their number must correspond to the number of II-GI group selectors. If it be considered that the II-GI group selectors participate in switching not only of transit communications, but also of communications originating from the local subscribers of the given station, then the solution indicated would be erroneous. But to divide each group of II-GI group selectors into 2 independent subgroups designed for separate service of one and another connections is irrational because of the substantial loss in the number of selector devices.

The most expedient solution which, without dividing the general groups of the II-GI group selectors into subgroups, affords the possibility of using the regenerators exclusively for transit loads, consists of using special transit selectors. The number of the latter must correspond to the number of regenerators. These selectors are included in the circuit between the regenerators and the II-GI group selectors, the output field of the transit selectors being connected in parallel with the field of the corresponding decades of the I-GI group selectors.

The usual step-by-step rotating selectors of the Shi-11 (or 11 contacts) can be employed in the capacity of transit selectors. Their function comprises the free selection of unoccupied II-GI group selectors in the interval of time between the passage of 2 series of impulses of dialling controlled by the work of IV-GI group selectors and II-GI group selectors.

A skeletal diagram of the connection of the regenerator in a station of the automatic system with use of transit selectors in shown in Figure 3. The operation of the circuit consists of the following.

When the first series of impulses of dialling, which determine the need of establishing a transit connection, enter along the channel TT to the station the brushes of IV-GI group selectors, which have at first completed a forced lifting motion, and after that a free rotating movement, are connected through the circuit of the additional device DVU to one of the unoccupied transit selectors TI. The latter comes into action, and its brushes rotating at somewhat heightened speed, stop at the output to the free device of the corresponding group of II-GI group selectors. When the next series of impulses enters, this II-GI group selector accomplishes the connection with the open channel in the direction of the station called.

On the entry of the reply signal from the side of the subscriber called, the switching relay V operates in the circuit DVU and the regenerator is connected to the communications.

The examined method of connecting the regenerators secures their most economic and rational use at automatic stations of subscribers' telegraph.

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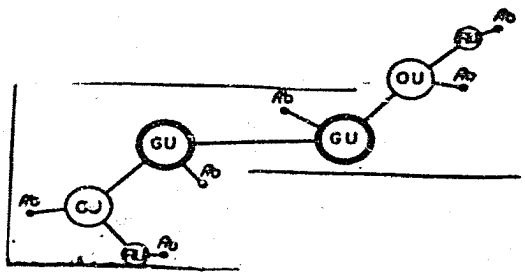


FIGURE 1

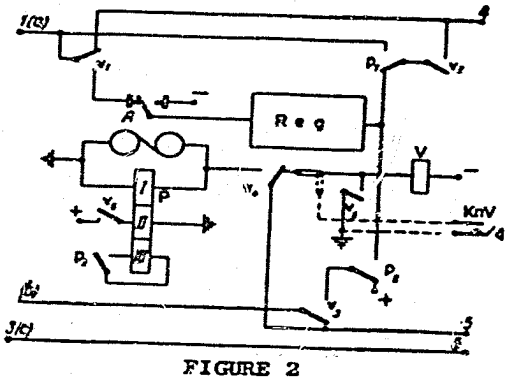


FIGURE 2

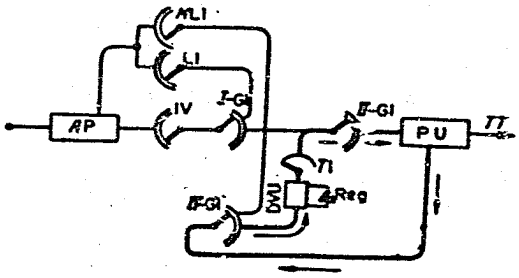


FIGURE 3

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